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Role of laparoscopic surgery in blunt abdominal trauma; retrospective analysis in a tertiary trauma center

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Abstract

Purpose Trauma is a significant health concern globally and is one of the leading causes of illness and death. The laparoscopic approach has gained popularity in trauma care since its inception, becoming increasingly favored for both diagnostic and therapeutic purposes. This study aims to reduce unnecessary laparotomies and assess the effectiveness of laparoscopy in managing patients with blunt abdominal trauma.

Methods The study is a descriptive retrospective study using the medical records of patients with blunt abdominal trauma who were managed with laparoscopy in the Department of General Surgery, King Abdulaziz Medical City in Riyadh. The study period was from 2019 to 2023 and included patients > 18 years with abdominal blunt injury, hemodynamically stable patients, and responding to resuscitation. The relationship between laparoscopic procedures according to the patient's demographic and characteristics was conducted using the Fischer Exact test and independent sample t-test. Values were considered significant with a p-value of less than 0.05.

Results In this study, 74 patients were included, with 94.6% being males. The average age of the patients was 36.3 years (standard deviation of 12.5 years). The primary cause of trauma was motor vehicle accidents (MVAs), accounting for 91.9% of cases. The most common surgical approach used was laparotomy, performed in 71.6% of patients. Additionally, CT scans revealed that solid organ injuries were the most frequently detected type of injury, occurring in 41.9% of cases. Following surgery, 78.4% of the patients underwent therapeutic procedures after laparotomy, while 37.8% received therapeutic interventions post-laparoscopy.

Conclusion While laparoscopic techniques have been used for decades in abdominal surgeries, a consensus on their effectiveness and accuracy in diagnosing blunt abdominal injuries in trauma settings is still lacking. Laparoscopy is considered safe and feasible for hemodynamically stable patients, and our findings suggest it is equally effective in trauma cases for those who can tolerate the procedure. We recommend conducting further studies with larger sample sizes and more variables to provide sufficient data to accurately assess the efficacy and safety of laparoscopy in trauma situations.

Keywords Laparoscopic, Trauma, Blunt, Abdominal

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Introduction

Trauma is a significant health issue worldwide and is one of the leading causes of illness and death, especially among young adults, accounting for 1 in every 10 deaths [1]. While laparotomy has traditionally been the standard surgical procedure for trauma, laparoscopy has gained popularity since its introduction in the 1980s [2]. This change has led to fewer unnecessary laparotomies and better outcomes in elective abdominal surgery [3, 4]. The laparoscopic method has been utilized in abdominal trauma as a diagnostic tool for many years [5]. However, diagnosing blunt intraperitoneal injuries accurately is challenging, especially in cases of hollow organ injuries where symptoms may not be apparent. Additionally, identifying intestinal injury can be more difficult [6, 7]. Although laparoscopy offers benefits like reduced pain, faster recovery, and shorter hospital stays compared to laparotomy, there is an ongoing debate regarding its widespread acceptance in trauma cases [3]. Laparoscopy serves both diagnostic and therapeutic purposes, although its benefits in abdominal trauma are still under review [5]. According to A. Allam et al. laparoscopy is a feasible and safe option for hemodynamically stable patients with blunt and penetrating abdominal trauma, it can provide minimally invasive surgery in diagnosing and repairing injuries while avoiding unnecessary

Table 1	Demographic, clinical	characteristics, a	and surgical
annroac	h of the natients who h	had blunt trauma	(n-74)

approach of the patients who had blunt trauma $(n=74)$					
Study variables	N (%)				
Age in years (mean ± SD)	36.3 ± 12.5				
• ≤ 35 years	43 (58.1%)				
•>35 years	31 (41.9%)				
Gender					
• Male	70 (94.6%)				
• Female	04 (05.4%)				
Mode of trauma					
motor vehicle accident (MVA)	68 (91.9%)				
• Fall	01 (01.4%)				
Assault	01 (01.4%)				
• Hit by animal	01 (01.4%)				
Pedestrian involved in MVA	03 (04.1%)				
Belt injury	01 (01.4%)				
CT findings					
Free air	06 (08.1%)				
• Solid organ injury	31 (41.9%)				
Mesenteric injury	18 (24.3%)				
Suspicion of bowel injury	21 (28.4%)				
Free fluid/Hemoperitoneum	23 (31.1%)				
Mesenteric injury with the presence of free peritoneal	03 (04.1%)				
fluid					
Surgical approach					
Laparoscopy	13 (17.6%)				
Laparotomy	53 (71.6%)				
Laparoscopic converted to open	08 (10.8%)				

laparotomies. Research in this field is continuously progressing, promising further advancements in the future [8].

To date, the literature supports and recommends the use of laparoscopy in selected cases of abdominal trauma within trauma settings. This recommendation is based on its effectiveness in reducing the number of unnecessary laparotomies and in identifying missed injuries. Therefore, this study aims to help avoid unnecessary laparotomies and to evaluate the efficacy of laparoscopy in managing patients with blunt abdominal trauma. It will assess the advantages and disadvantages of using laparoscopy in this context.

Method

The study is a descriptive retrospective study using the medical records of patients with blunt abdominal trauma who were managed with laparoscopy in the Department of General Surgery, King Abdulaziz Medical City in Riyadh. The study period was from 2019 to 2023. Inclusion criteria involved any patient (Above 18 years old, presented with abdominal blunt injury, hemodynamically stable patient, and responding to resuscitation). The study excluded any patient (younger than 18 years old, presented with a penetrating abdominal injury, hemodynamically unstable patient, un-responding patient, and any patients with signs and symptoms of peritonitis requiring immediate exploratory laparotomy). The study illustrated descriptive data of patients undergoing diagnostic laparoscopy in comparison to patients undergoing laparotomy in terms of age, gender, mode of trauma, CT findings, injured organs, postoperative complications, mortality, ICU admission, and length of hospital stay.

Statistical analysis

The data were analyzed using the software program Statistical Packages for Software Sciences (SPSS) version 26 (Armonk, New York, IBM Corporation, USA). Descriptive statistics were given as numbers and percentages (%) for all categorical variables, while mean and standard deviation were given as continuous variables. The relationship between laparoscopic procedures according to the patient's demographic and characteristics was conducted using the Fischer Exact test and independent sample t-test. Values were considered significant with a p-value of less than 0.05.

Results

This study analyzed 74 patients who suffered blunt abdominal trauma. As described in Table 1, the mean age of the patients was 36.3 (SD 12.5) years, with more than half (58.1%) aged 35 years or less. Most of the injured patients were males (94.6%). The most prominent cause of trauma was MVA (91.9%), while the most common

surgical approach was laparotomy (71.6%). In addition, solid organ injury was the most detected injury based on CT findings (41.9%).

In Tables 2 and 37.8% of the patients underwent therapeutic laparoscopic surgery, whereas 78.4% underwent therapeutic laparotomy surgery. The most common complication postoperatively was Deep venous thrombosis (DVT). The rate of mortality was 5.4%. Additionally, the mean ICU and hospital stay days were 7.88 and 33.2, respectively.

Figure 1 illustrates that the most common injured organ is the small bowel (39.2%), followed by the spleen (36.5%) and mesentery (27%). In Fig. 2, the most common type of procedure was bleeding control (41.9%), followed by segmental resection of small bowel (36.5%) and splenectomy (23%).

When measuring the efficacy of the type of procedure (laparoscopic vs. laparotomy) in terms of the demographic, clinical characteristics, and outcome of the patients (Table 3), it was observed that the differences in efficacy between laparoscopic and laparotomy in relation to age, gender, mode of trauma, CT findings, injury organ, postop complication, mortality, ICU stay and length of hospital stay were not significantly different (all p > 0.05).

Discussion

Minimally invasive surgical techniques, such as laparoscopic surgery, have gained widespread agreement on their advantages over traditional laparotomy. The benefits noted in the literature include avoiding a sizeable surgical scar, being less painful for the patient, facilitating faster recovery, and reducing the surgically induced inflammatory response [9]. One area that continues to provoke discussion is the role of utility in trauma settings,
 Table 2
 Patients' surgery outcome, postoperative complications,

 ICU admission, length of stay, and mortality (n=74)

Variables	N (%)
Outcome related to laparoscopic ⁽ⁿ⁼³⁶⁾	
Negative	04 (05.4%)
Therapeutic	28 (37.8%)
Converted to open	04 (05.4%)
Outcome related to laparotomy ⁽ⁿ⁼⁶³⁾	
Negative	05 (06.8%)
Therapeutic	58 (78.4%)
Postop complications	
• None	49 (66.2%)
Respiratory	04 (05.4%)
Surgical site infection (SSI)	03 (04.1%)
Intra-abdominal collection	02 (02.7%)
Deep venous thrombosis (DVT)	05 (06.8%)
• Other	09 (12.2%)
Intensive care unit (ICU) stay in days (mean \pm SD)	7.88 ± 12.3
Length of hospital stay in days (mean \pm SD)	33.2 ± 46.4
Mortality	
• Yes	04 (05.4%)
• No	70 (94 6%)

where agreement remains challenging to achieve [3]. As technology advances and expertise with laparoscopy increases, its use in acute surgical management, particularly trauma surgery, is also expanding [10, 11]. The diagnosis of clinically significant intraperitoneal injuries in blunt trauma remains challenging to achieve, even with the advancements in diagnostic methods over the past few decades. Our study found no significance between patients who underwent laparotomy and laparoscopy when it comes to demographics, CT findings, post-operative course, or ICU stay/recovery.





Fig. 2 Type of procedure

Most of our patients were young adults, 58.1% being less than 35 years of age. Sahu et al. reported similar results where 21-30 years old accounted for the most significant percentage of blunt abdominal trauma cases (36.3%), followed by the age group of 31-40 years old (27.2%) [12]. These figures are not unlike literature published in the Americas. Bain et al., based in the eastern USA, found in their study spanning 10 years, that 31 years of age was the average [13]. In addition, Cubabased Rodas et al. found that young adults comprised the majority of the population who experience traumatic injuries [14]. These findings are contrasted by those published by some Europe and Asia-based authors. Malkomas et al. and Lin et al., based in Germany and Taiwan, respectively, found that the average ages were around mid-thirties to early forties. Regarding gender, males predominate at 94.6%, consistent with the literature [3, 12, 13].

The most prevalent cause of trauma was motor vehicle accidents (91.9%), which was followed by pedestrians involved in MVAs (04.1%). These findings are consistent with a study by Abdelshafy et al. that found that motor vehicle accidents more frequently cause blunt abdominal trauma [15]. Furthermore, similar findings were found in a study conducted by Sahu et al., in which the most common cause of injury was a road traffic accident (72.7%) [15]. Assault cases were negligible in our study, with 1 case being recorded. This contrasts with studies published by Hietbrink et al., where 22% of all traumas undergoing surgery were penetrating injuries [16].

Regarding imaging, most of our CT findings were of solid organ injuries (41.9%), followed by free fluid/hemoperitoneum (31.1%). Similarly, Alzarouni N et al. discovered that the most common finding in CT scans was solid organ injuries [17]. In contrast, Parajuli P et al. found that the most prevalent CT scan finding was hemoperitoneum (66.1%), followed by pneumoperitoneum (58.8%) [18]. The most frequently injured organ in our cohort was the small bowel, accounting for 39.2% of cases, followed by the spleen (36.5%) and mesentery (27%). Comparing our results to similar studies in the literature, we found both similarities and differences. Kyoung et al. reported a similar pattern of organ injury distribution, with the small bowel perforation being the most commonly injured organ in patients undergoing laparotomy for blunt intra-abdominal trauma⁴. However, in contrast to our findings, Ahmed et al. found that the spleen was the predominant injured organ in their cohort of patients undergoing laparoscopy for similar injuries [15]. Computerized axial tomography scans (CT scans) are advantageous in providing a way to identify or even diagnose injuries without requiring violation of the peritoneum. That said, the scans do not provide ample effectiveness in the study of mesenteric lesions and hollow visceral lesions, especially when it comes to the trauma setting [19]. Laparoscopy in the setting of trauma has shown its effectiveness in detecting abdominal traumatic injuries with high precision while lowering rates of nontherapeutic laparotomies [19].

In terms of postoperative complications, laparoscopy patients are just as prone as laparotomy patients to develop DVT, intra-abdominal collection, and surgical site infection. Similarly, a recent retrospective study compared 47 patients undergoing laparotomy to 57 urgent laparoscopy patients and found that laparoscopy reduced laparotomy rates and was as effective while leaving postoperative complications unaltered [20]. Moreover, the average number of days spent in the ICU and hospital for patients who underwent laparotomy was 7.59 and 33.2, respectively, while for laparoscopic patients, these numbers were 9.23 and 32.9. The results indicate no statistically significant difference between the two groups. In contrast, Ahmed et al. demonstrated that laparoscopy resulted in a shorter mean ICU stay (1-3 days) and overall hospital stay compared to laparotomy (2-5 days) [15]. These findings, in contrast to ours, match published **Table 3** Relationship between the type of procedure among the demographic, clinical characteristics, and post-operative outcome of the patients who had blunt trauma (n=74)

	Type of procedure	Type of procedure	
	Laparoscopic N (%) (_n =13)	Laparotomy N (%) (_η =61)	
Age group			
• ≤ 35 years	07 (53.8%)	36 (59.0%)	0.765
• > 35 years	06 (46.2%)	25 (41.0%)	
Gender			
• Male	11 (84.6%)	59 (96.7%)	0.140
• Female	02 (15.4%)	02 (03.3%)	
Mode of trauma			
• MVA	11 (84.6%)	57 (93.4%)	0.283
• Non-MVA	02 (15.4%)	04 (06.6%)	
CT findings			
• Free air	01 (07.7%)	05 (08.2%)	1.000
• Solid organ injury	06 (46.2%)	25 (41.0%)	0.765
Mesenteric injury	05 (38.5%)	13 (21.3%)	0.283
Suspicion of bowel injury	05 (38.5%)	16 (26.2%)	0.499
Free fluid/Hemoperitoneum	07 (53.8%)	16 (26.2%)	0.095
Mesenteric injury with the presence of free peritoneal fluid	01 (07.7%)	02 (03.3%)	0.445
• Other	03 (23.1%)	07 (11.5%)	0.366
Injured organ			
• Spleen	04 (30.8%)	23 (37.7%)	0.757
• Liver	04 (30.8%)	12 (19.7%)	0.460
Small bowel	04 (30.8%)	25 (41.0%)	0.549
• Duodenum	01 (07.7%)	05 (08.2%)	1.000
• Colon	01 (07.7%)	15 (24.6%)	0.275
• Mesentery	05 (38.5%)	15 (24.6%)	0.319
Bleeding without organ injury	01 (07.7%)	07 (11.5%)	1.000
Postop complication			
• Yes	02 (15.4%)	23 (37.7%)	0.197
• No	11 (84.6%)	38 (62.3%)	
Mortality			
• Yes	0	04 (06.6%)	1.000
• No	13 (100%)	57 (93.4%)	
	Mean ± SD	Mean \pm SD	P-value [‡]
ICU stay in days	9.23±21.9	7.59 ± 9.42	0.666
Length of hospital stay in days	32.9±50.7	33.2±45.9	0.982

§ P-value has been calculated using Fischer Exact test

⁺ P-value has been calculated using an independent sample t-test

** Significant at p<0.05 level

findings about the effectiveness of laparoscopy in aiding with faster recovery and reducing hospital stays [3, 13]. Our data showing no significance between the two groups could be less related to the effectiveness of laparoscopy in our experience and more associated with the small sample size.

Conversion to laparotomy was witnessed in 4 (5.4%) cases, which is on the low end of published literature. Lim et al. conducted research and found that the rate of conversion to open laparotomy was 18% (9/50), with reasons for conversion including uncontrolled bleeding,

substantial hematoma or spilled intestinal contents, huge adhesions from past surgery, and impaired sight due to edema [4]. When it comes to mortality, Syed et al. found that laparoscopy was associated with lower mortality rates compared to laparotomy [2]. This contrasts with our findings, which did not show a significant difference in mortality rates between the two procedures.

There are several limitations to this study. First, it is based on a single center and is retrospective with selection bias. Second, the utilization of laparoscopy varies depending on the skill set of the operating surgeon. Finally, and most importantly, our sample size is considerably small compared to multicenter or national studies. This might explain the lack of significance between the two surgical approaches in most domains.

Conclusion

In conclusion, although the laparoscopic approach has been employed as a valuable technique in abdominal surgical interventions for several decades, there remains a lack of consensus among trauma institutions regarding its effectiveness and accuracy in the diagnosis of blunt abdominal injuries in trauma scenarios. This uncertainty underscores the necessity for additional research to clarify the role of this minimally invasive technique within trauma management guidelines. Laparoscopy is safe and feasible for hemodynamically stable patients. In trauma cases where patients can tolerate laparoscopy, we found it equally compelling. We recommend conducting further studies with larger sample sizes and a wider range of variables to provide sufficient data for delineating laparoscopy's true efficacy and safety in trauma.

Abbreviations

CT Computed Tomography

- ICU Intensive Care Unit
- MVA Motor Vehicle Accidents
- DVT Deep Venous Thrombosis

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None.

Author contributions

All authors (Rifan Alyami, Ahad Alotaibi, Leen Almohayya, Ajyad Al Jawad, Raghad Almukhayzim, Abeer Alhoumedan, Rakan Aldusari) contributed equally to this article.

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Data availability

The datasets analysed during the current study available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Institutional Review Board at King Abdullah International Medical Research Center (KAIMRC). Due to the retrospective nature of the study IRB approval No.: IRB/1673a/23, and study number: NRC23R/365/05 waived the need of obtaining informed consent.

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Competing interests

The authors declare no competing interests.

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References

- Albabtain I, Alfehaid O, Alghunaim M et al. Epidemiology of Adult Trauma at a Tertiary Hospital in Riyadh, Saudi Arabia. Int J Med Res Heal Sci. 2019.
- Zafar SN, Onwugbufor MT, Hughes K, et al. Laparoscopic surgery for trauma: the realm of therapeutic management. Am J Surg. 2015;209(4):627–32. https://doi.org/10.1016/J.AMJSURG.2014.12.011.
- Wang J, Cheng L, Liu J, et al. Laparoscopy vs. Laparotomy for the management of Abdominal Trauma: a systematic review and Meta-analysis. Front Surg. 2022;9. https://doi.org/10.3389/FSURG.2022.817134/FULL.
- Lim KH, Chung BS, Kim JY, Kim SS. Laparoscopic surgery in abdominal trauma: a single center review of a 7-year experience. World J Emerg Surg. 2015;10(1). https://doi.org/10.1186/S13017-015-0007-8.
- Nicolau AE, Craciun M, Vasile R, Kitkani A, Beuran M. The role of Laparoscopy in Abdominal Trauma: a 10-Year review. Chirurgia (Bucur). 2019;114(3):359–68. https://doi.org/10.21614/CHIRURGIA.114.3.359.
- Koganti D, Hazen BJ, Dente CJ, Nguyen J, Gelbard RB. The role of diagnostic laparoscopy for trauma at a high-volume level one center. Surg Endosc. 2021;35(6):2667–70. https://doi.org/10.1007/S00464-020-07687-1.
- Wafa A, Elsagier M, Friwan RBA. Role of Laparoscopy in Abdominal Trauma. Arch Hell Med. 2019;6(2). https://doi.org/10.23937/2378-3397/1410100.
- Allam A, Ibrahim HA, Tag El-Din IM, Mahmoud MA. ROLE OF LAPAROSCOPY IN MANAGEMENT OF ABDOMINAL TRAUMA. AI-Azhar Med J. 2020;49(3):1027– 44. https://doi.org/10.21608/AMJ.2020.91626.
- Garry R. Laparoscopic surgery. Best Pract Res Clin Obstet Gynaecol. 2006;20(1):89–104. https://doi.org/10.1016/J.BPOBGYN.2005.10.003.
- 10. Uranüs S, Dorr K. Laparoscopy in Abdominal Trauma. Eur J Trauma Emerg Surg. 2010;36(1):19–24. https://doi.org/10.1007/S00068-010-9219-5.
- Uranüs S. Minimally invasive surgery in Trauma and emergencies. Eur J Trauma Emerg Surg. 2010;36(1):1. https://doi.org/10.1007/S00068-010-9218-6
- 12. Sahu RK, Chandrakar S, Ratre R, Agrawal SN. The study on the role of laparoscopy in blunt abdominal trauma: a case series. Int Surg J. 2022;9(3):659–63. https://doi.org/10.18203/2349-2902.ISJ20220639.
- Bain K, Meytes V, Chang GC, Timoney MF. Laparoscopy in penetrating abdominal trauma is a safe and effective alternative to laparotomy. Surg Endosc. 2019;33(5):1618–25. https://doi.org/10.1007/S00464-018-6436-1.
- Abreu YL, Fernández Gómez A, Elizabeth G, Rodas S. Evaluación de criterios para laparotomía en lesiones abdominales por arma blanca. *Rev Cuba Cirugía*. 2016;55(1):0–0. http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S003 4-74932016000100001&Ing=es&nrm=iso&tlng=es. Accessed June 1, 2024.
- Ouf TI, ElShinawi ME, Abbas AA, El Sayed Nagy M. Role of Laparoscopy in Blunt Abdominal Trauma: a comparative prospective cohort study between Laparoscopy and Laparotomy in patients with Blunt Abdominal Trauma. QJM Int J Med. 2021;114(Supplement1). https://doi.org/10.1093/QJMED/HCAB097 .046.
- Hietbrink F, Smeeing D, Karhof S, et al. The outcome of trauma-related emergency laparotomies in an era of far-reaching specialization. World J Emerg Surg. 2019;14(1). https://doi.org/10.1186/S13017-019-0257-Y.
- Alzarouni N, Salem A, Nurelhuda NM, Osman R, Eltayyeb Y. Role of laparoscopy in patients with abdominal trauma: Rashid Hospital Trauma Center experience. J Emerg Med Trauma Acute Care. 2022;2022(5):30. https://doi.org /10.5339/JEMTAC.2022.30/CITE/REFWORKS.
- Parajuli P, Kumar S, Gupta A, et al. Role of Laparoscopy in patients with Abdominal Trauma at Level-I Trauma Center. Surg Laparosc Endosc Percutan Tech. 2018;28(1):20–5. https://doi.org/10.1097/SLE.00000000000379.

- Johnson JJ, Garwe T, Raines AR, et al. The use of laparoscopy in the diagnosis and treatment of blunt and penetrating abdominal injuries: 10-year experience at a level 1 trauma center. Am J Surg. 2013;205(3):317–21. https://doi.or g/10.1016/J.AMJSURG.2012.10.021.
- Lee PC, Lo C, Wu JM, Lin KL, Lin HF, Ko WJ. Laparoscopy decreases the laparotomy rate in hemodynamically stable patients with blunt abdominal trauma. Surg Innov. 2014;21(2):155–65. https://doi.org/10.1177/1553350612474496.

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